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ABSTRACT

Marginal cost is the cost of producing an additional unit. In higher education, one marginal cost would be cost of educating an additional student. Formula-based budget determination for public higher education is usually based on average cost per student. This study estimates marginal cost and compares it with average cost. There are several methods for estimating marginal costs; the regression method is the central focus of this paper. It involves using regression analysis to estimate the coefficients, or marginal effects, of various independent variables. Two regression equations were developed using 1982 and 1983 data from the University of Massachusetts, Amherst. In both equations, the marginal cost was below the average cost. Through the average cost per person is lower than the average cost per Full Time Equivalent (FTE), the marginal cost of instruction using headcount as a unit of measurement was noticeably higher than the marginal cost of educating an FTE. The results demonstrate that formula-driven budgets based on average cost ignore the existence of economies of scale. Marginal cost is a more accurate cost to use when measuring increases or decreases. (BW)

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MARGINAL COSTS AND FORMULA-BASED FUNDING

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Marginal cost is the cost of producing an additonal unit. In higher education, one marginal cost would be the cost of educating an additional student. Formula-based budget determination for public higher education is usually based on average cost per student. This study estimates marginal cost and compares it with average cost.

Because marginal costs are believed to be lower than average costs, the use of average costs in calculating budgets was never an issue in higher education during the expansionary years. Institutions would receive more money than necessary to educate additional students and use these extra funds to improve facilities or the quality of programs. However, today, if a public institution experiences a decline in enrollment, then a budget based on average cost will take away more funds from the school than would the use of marginal cost or the true cost of educating these additional students. These cuts could damage or hamper the mission of the institution.

There are several methods for estimating marginal costs: The incremental method, the fixed-variable cost method and the regression method. Each method has its own particular set of advantages and drawbacks.

The incremental method consists of identifying the effect of changes in the number of students on total costs. These effects are distinguished from changes in total costs that are a direct result of environmental or decision factors. For example, inflation would be considered as an environmental factor; whereas, an increase in faculty salaries due to a collective bargaining agreement is an administrative decision. Although it is theoretically a simple method, it is difficult to separate the interactive effects of changes in enrollment, the environment and administrative

decisions.

The second method, the fixed-variable cost method, separates fixed costs from the costs that vary with enrollment. In this instance, marginal costs equal average variable costs. For example, plant operations, inflation factors and cost increases due to administrative decisions could be considered as fixed costs, and other costs that vary due to enrollment changes could be defined as variable costs. This method helps in identifying key cost variables and protects certain needed services and facilities from funding cutbacks due to environmental factors; however, a political process must determine which costs are fixed and which are not fixed. Furthermore, in the absolute long run, all costs are marginal and in the absolute short run all costs are fixed. An appropriate planning period must be chosen that is consistent with the purpose of the cost analysis.

The third method, the regression method, is the central focus of this paper. It involves using regression analysis to estimate the coefficients, or marginal effects, of various independent variables. This method is most useful in determining general cost patterns as opposed to determining actual marginal costs because results vary with the choice of functional form, linear or non-linear, of the equation (Allen and Brinkman, 1983).

METHODOLOGY

Regression analysis requires the specification of a model. In this instance, only two very simple equations were developed due to theoretical constraints and data limitations.

The regressions on the equations below used 1982 and 1983 data from the Amherst campus on instructional costs by general program areas and program area enrollment. Although several non-linear forms of the equations were estimated the linear model appeared to be the best.

(1) $\text{Cost}^{*} = a_o + a_1 \text{ Level} + a_2 \text{ Program Area} + a_3 \text{ FTE} + u_a$

(2) $\text{Cost} = a_o + a_1 \text{ Level} + a_2 \text{ Program Area} + a_3 \text{ Headcount} + u_a$

Where

Cost = Faculty salaries

a = coefficients

u = disturbance term

Level = Undergraduate = 1

= Graduate = 2

Program Area = Arts and Sciences = 1

Business = 2

Engineering = 3

Allied Health = 4

Other = 5

FTE = Full Time Equivalent = the number of undergraduate credit hours divided by 15 and the number of graduate credit hours divided by 12

Headcount = a count on the number of students in attendance

* Cost data have been transformed into 1983 dollars

The dependent variable, faculty salaries, was chosen because of data limitations. However, it does represent a large portion of general program area costs. The first two independent variables controlled for variation in instructional cost due to level of education or general program area. The other two independent variables, headcount and FTE, measured the influence of enrollment changes on instructional costs.

Separate regressions were run on these two equations using ordinary least squares. The first used FTE as the unit of measurement for enrollment, and the second used headcount. This quantified the changes in marginal cost that result from using different units of measurement.

RESULTS

The results follow the same pattern that was found in various other studies on marginal costs in higher education (Brovender, 1974, Verry and Davies, 1976, Razin and Campbell, 1972). The model results supported the studies' hypothesis that marginal cost was below average cost indicating the existence of economies of scale.

Regression Results

Equation 1

	Level	Program Area	FTE
Regression Coefficient	2595098	-841054	1221
t statistic	(4.2)*	(2.9)*	(10.7)*

F statistic = 53* R^2 = .86
n = 20

Equation 2

	Level	Program Area	Headcount
Regression Coefficient	2813034	-1317467	1594
t statistic	(5.0)*	(-4.9)*	(11.6)*

F statistic = 63* R^2 = .88
n = 20

*significant at .05 and .01 level

The estimated coefficients for FTE and headcount are the marginal costs of instruction for one additional student.

Instructional Cost

Amherst Campus
1982-1983

Unit of Measurement	Average Cost	Marginal Cost
FTE student	1932	1221
Headcount	1791	1594

The marginal cost per FTE was 63% of the average cost per FTE. Most studies agree that the ratio lies between 55 and 65%. On the other hand, the ratio of marginal cost over average cost using headcount as the unit of measurement was much higher at 89%.

Significantly, the marginal cost of instruction using headcount as a unit of measurement was noticeably higher than the marginal cost of educating a FTE. This is of interest because average cost per person (headcount) is lower than average cost per FTE. Although it is less costly to educate a student body that contains part time students, an increase in part time students is more costly than an increase in more students taking full time courseloads. This may be due to the possibility that an increase in the number of students would be accompanied by a larger strain on course requirements and an expansion in alternative classroom hours as opposed to an increase in courseloads for existing students.

CONCLUSION

In essence, formula driven budgets that are based on average cost ignore the existence of economies of scale. Marginal cost is a more accurate cost to use when measuring increases or decreases.

In addition, formula driven budgets that are based on FTE enrollment do

not take into account that it is more expensive to educate an increase in part time students that might raise headcount but hold FTE growth constant or at a slower rate of increase.

The combination of average cost and strict adherence to one unit of measurement in determining budgets result in inequitable allocations. The use of marginal costs and growing awareness about the relationship between full time equivalent and headcount as units of measures for enrollment provide a more balanced method of budget determination.

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